Innovative Technologies Brought On Line at the Savannah River Site

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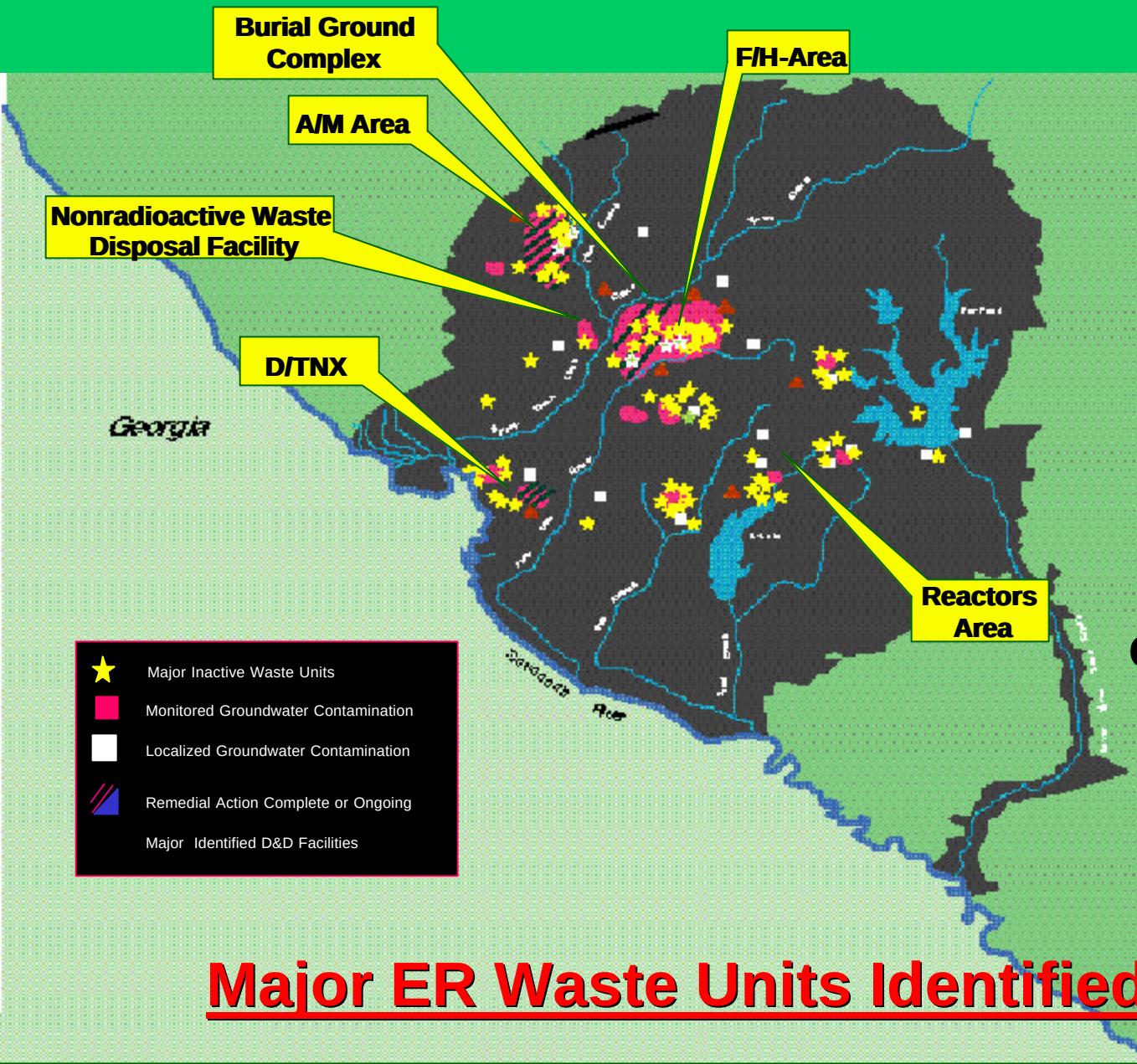
Innovation at SRS

- **Who We Are**
- **What We're Doing/Have Done**
- **How We Do Business**

Savannah River Site

Environmental Restoration Program



515
Waste Sites
306 Completed or in Remedial Design

500
Acres
340 Completed or in Remediation

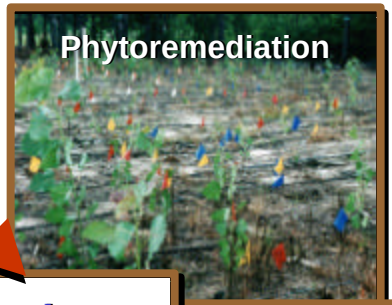
11 Groundwater Contamination Areas
8 Area Groundwater Remediation Systems Running
4.5 Billion Gallons Treated

Major ER Waste Units Identified at SRS

Evolution of Remediation at SRS

Muck & Truck

Chemical Plants



Natural Processes

Innovation at SRS

- Who We Are
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Airlift Recirculation Wells

TNX and A/M Areas

Issue: Recirculation wells were an emerging in-situ technology for the treatment of groundwater contaminated with volatile organic compounds.

Initial Deployment at TNX - **DIDN'T WORK**

Design objectives could not be met

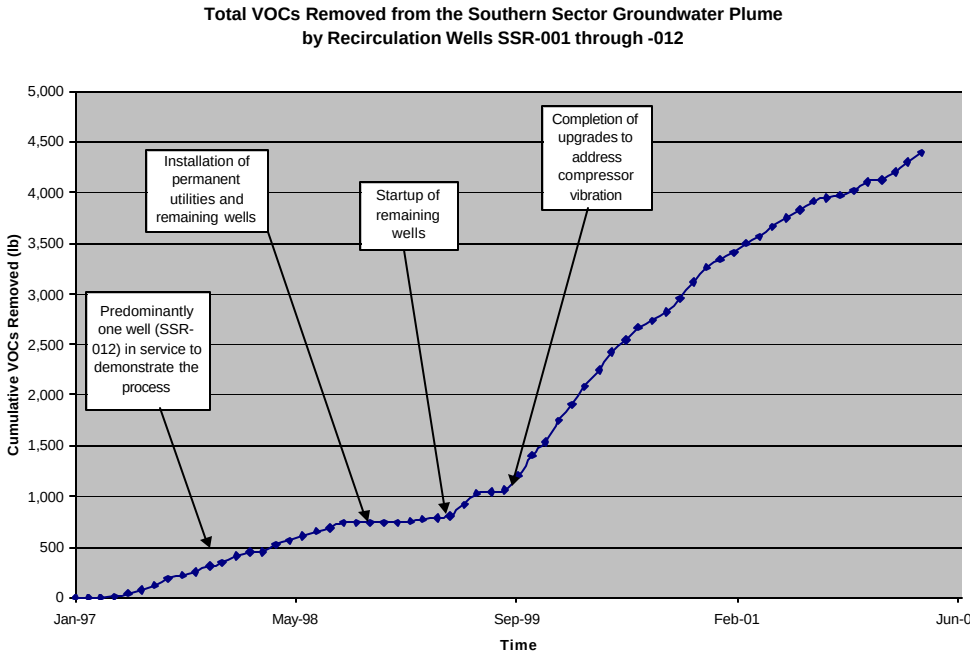
Geology at unit precluded efficient extraction of groundwater

Second Deployment at A/M Area - **STILL OPERATING**

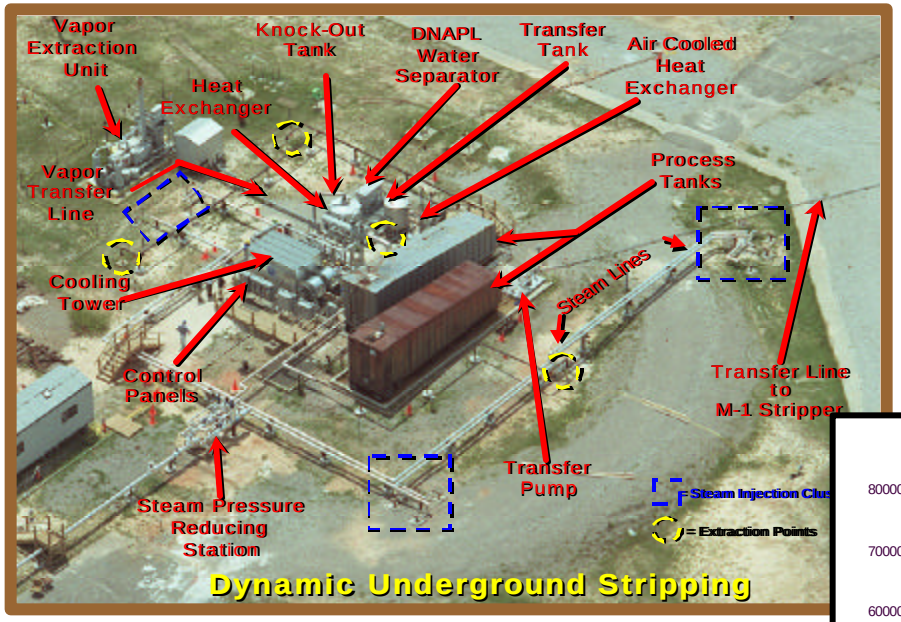
Geology conducive to establishing a re-circulation of groundwater

12 wells operating at Southern Sector, 4 of which have been retrofitted with a Mutli- In-well Aerator (MIA) enhancement (UC Davis) (wells with highest concentration)

11 more wells with MIA on line this year at the Miscellaneous Chemical Basin



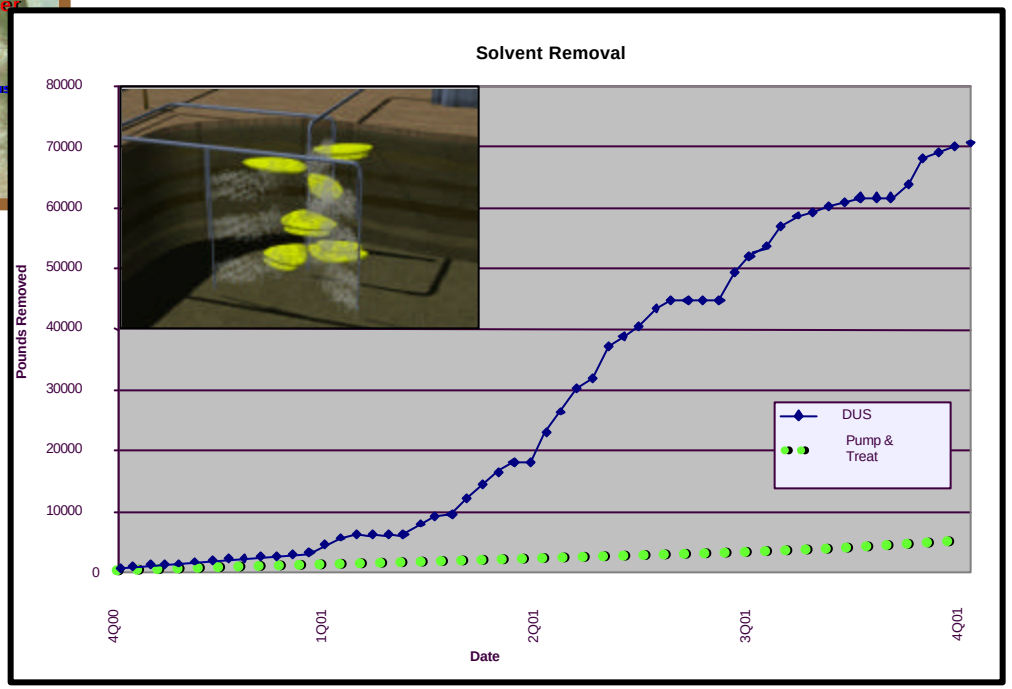
Dynamic Underground Stripping



Issue: Largest source of DNAPL (solvent) contamination in the vadose zone and groundwater in DOE, affects a regional aquifer,and is the second high risk in the Environmental Restoration program

Traditional Approach: Soil Vapor Extraction/Air Stripping

Innovation: **Dynamic Underground Stripping**



Cost Improvement: 30 times cheaper (>>$100M cost avoidance)

Performance Improvement: 15 times faster than Soil Vapor extraction and 7 times faster than Air Stripping

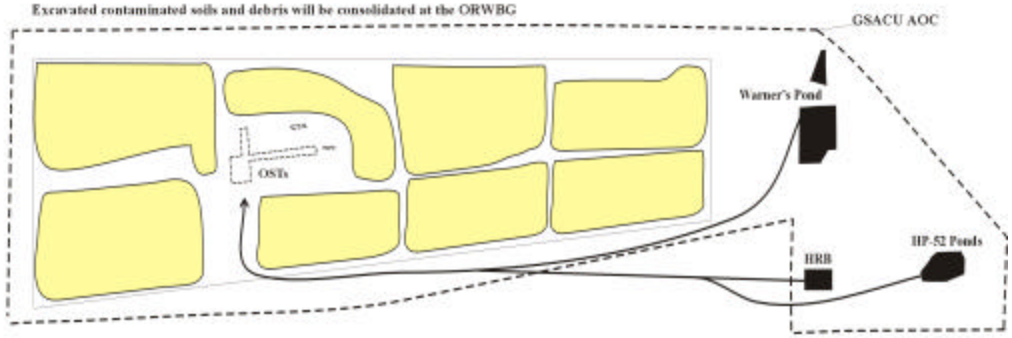
Old Radioactive Waste Burial Ground (ORWBG)

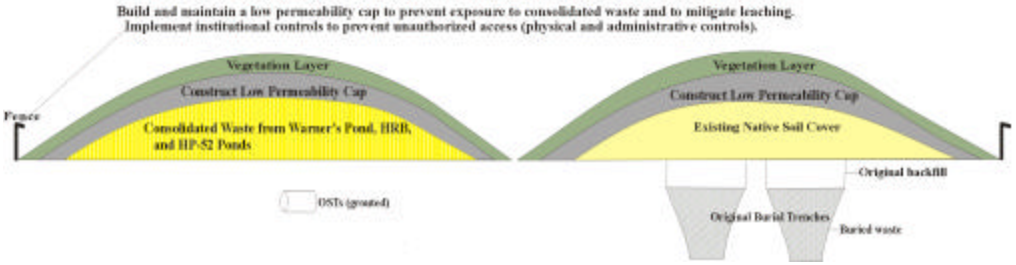
General Separations Area Consolidation Unit

Issue: Close waste site which contains buried radioactive waste and contaminated soil (containing ~600,000 curies) along with three other similar waste units and a portion of the Inactive Process Sewer Line that contains radionuclides. This unit represents the highest risk in the Environmental Restoration program

Traditional Approach: Close the units independently, off site out-of-state disposal of waste, and in-situ stabilization

Innovation: Consolidate and stabilize the three waste units into the ORWBG





Cost Improvement: Cost avoidance of $150M

Performance Improvement: Significantly reduces worker risk

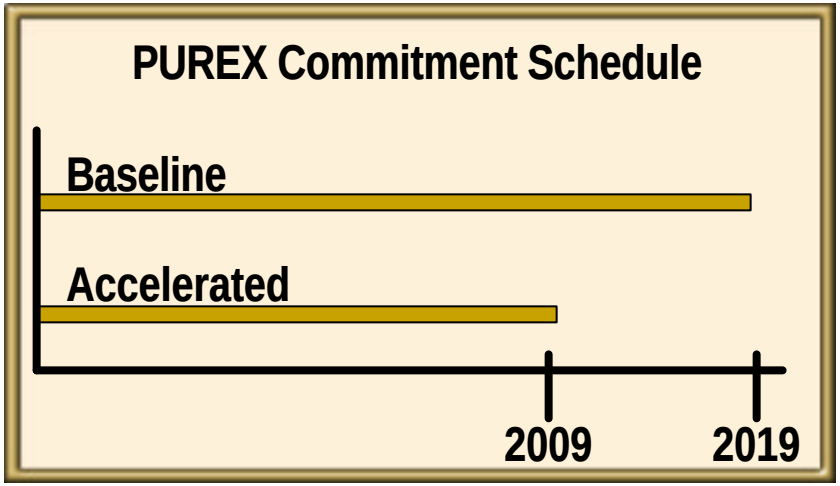
Expedites closure of sites 2 years

Solid Waste

Issue: Accelerate closure of the Consolidated Incinerator Facility and provide a solution for F Canyon solvent, PUREX (Plutonium Uranium Extraction)

Traditional Approach: Incineration

Innovation: Stabilization in a polymer or clay media (NOCHAR or Petroset)



PUREX Organic - Tank 33
NOCHAR A610

Cost Improvement: $85M plus the additional cost avoidance for F-Canyon PUREX

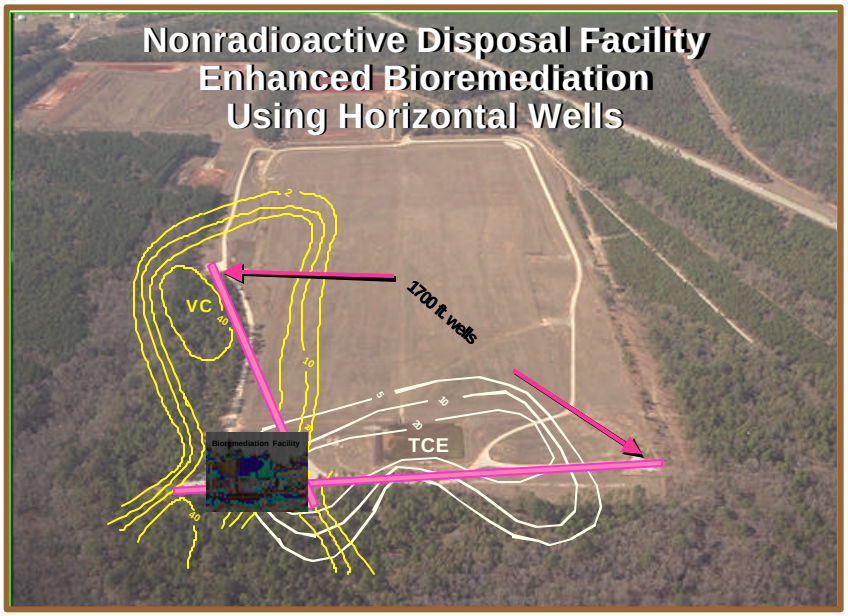
Performance Improvement: Significant risk reduction
Expedites schedule10 years

Natural Remediation

Natural Remediation

Nonradioactive Disposal Facility (NRDF)

Issue: NRDF is unique in that it takes advantage of multiple innovative approaches, including capping, groundwater cleanup methods, and modeling concepts.

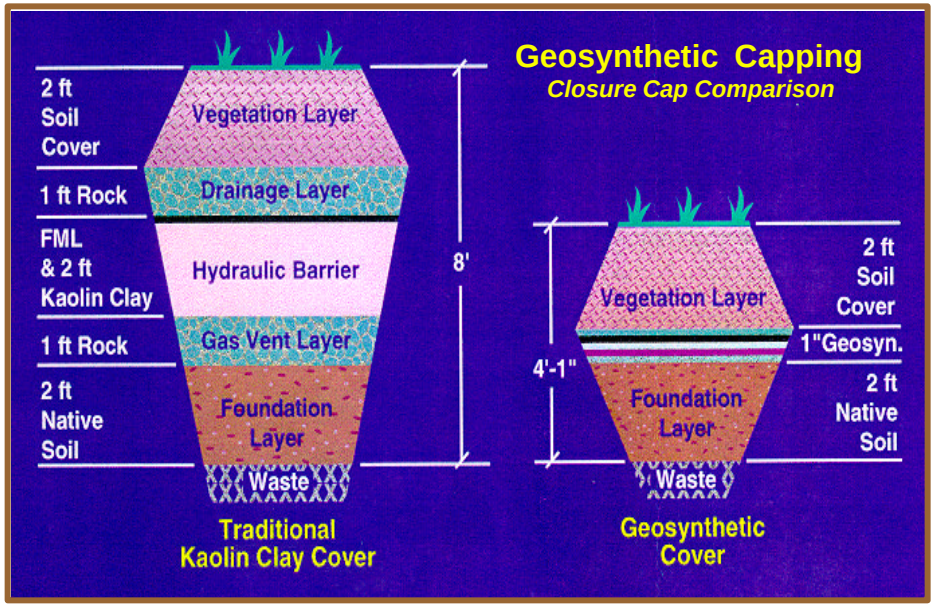


Groundwater Cleanup

Traditional Approach:	Pump and Treat
Innovation:	Bioremediation using horizontal wells
Cost Improvement:	$20 Million
Performance Improvement:	Expedites schedule by 20 years Expedites risk reduction to the environmental (Upper Three Runs Creek & seeps - point of exposure)

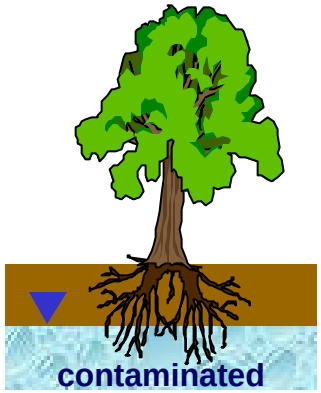
Geosynthetic Capping

Traditional Approach:	Clay Cap
Innovation:	Geosynthetic Cap
Cost Improvement:	$5.5 Million
Performance Improvement:	Expedites risk reduction to the groundwater by preventing contaminant migration caused by rainwater infiltration Expedites schedule 10 years



Advanced Modeling: Modeling will help determine how much contaminant can remain in the groundwater without increasing risk at the point of exposure.

Natural Remediation
Deployment of Phytoremediation

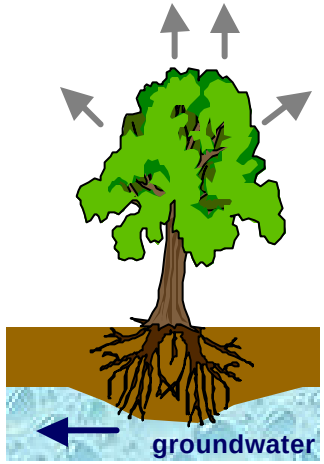


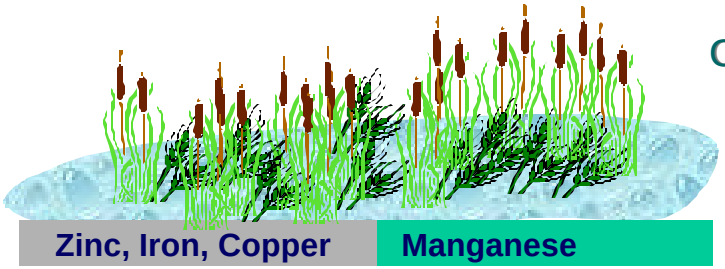
Destruction of organic contaminants in groundwater in the root zone of trees

In place

Hydraulic control of plumes by evapotranspiration

In place



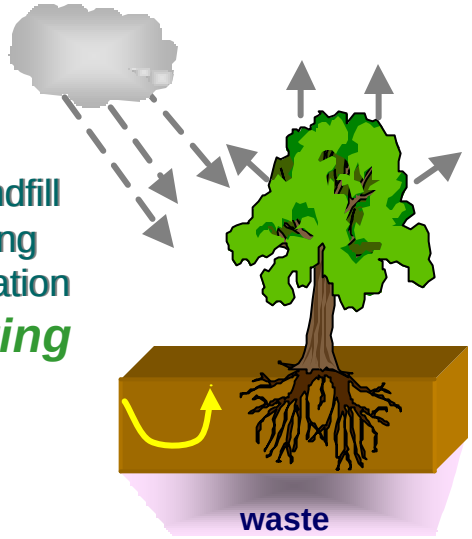


Constructed wetlands to precipitate heavy metals from surface waters

In place

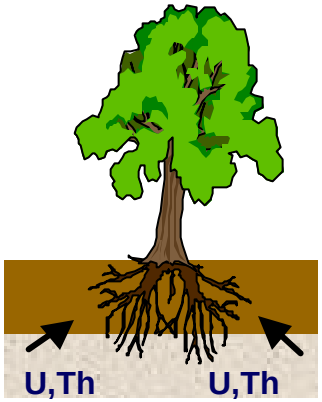
Vegetative landfill covers utilizing evapotranspiration

Field Testing



Removal of metals/rads from shallow soils by absorption into plant biomass

Planning



Natural Remediation
Phytoremediation Using Poplar Trees

D-Area poplar trees

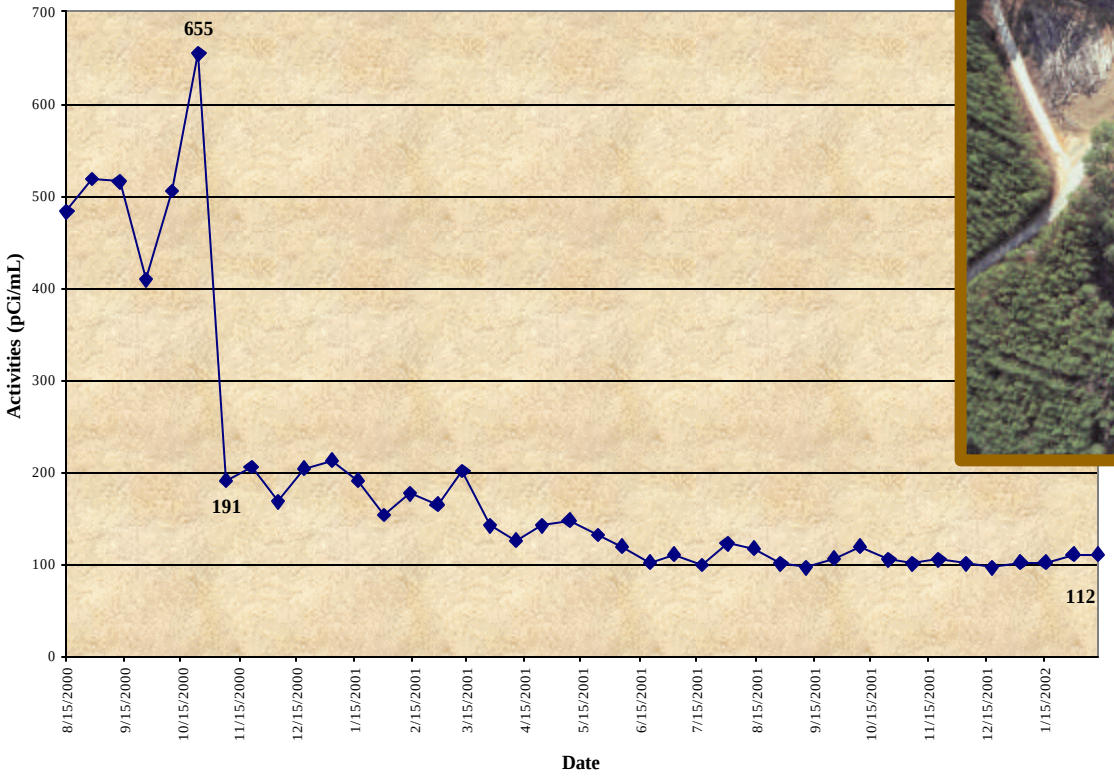
New poplar trees planted in A and M area planted March 2002

Natural Remediation
Tritium Phytoremediation Project

Issue: Tritium contaminated groundwater at the Mixed Waste Management Facility is impacting Fourmile Branch. This stream is the largest waste site contributor of tritium to the Savannah River and ultimately the general public

Traditional Approach: Pump, treat, and reinject
Innovation: **Phytoremedation**

Tritium Concentrations in Fourmile Branch



Cost Improvement: 4 times cheaper
($7.6M capital cost savings and
$49M operating cost avoidance)

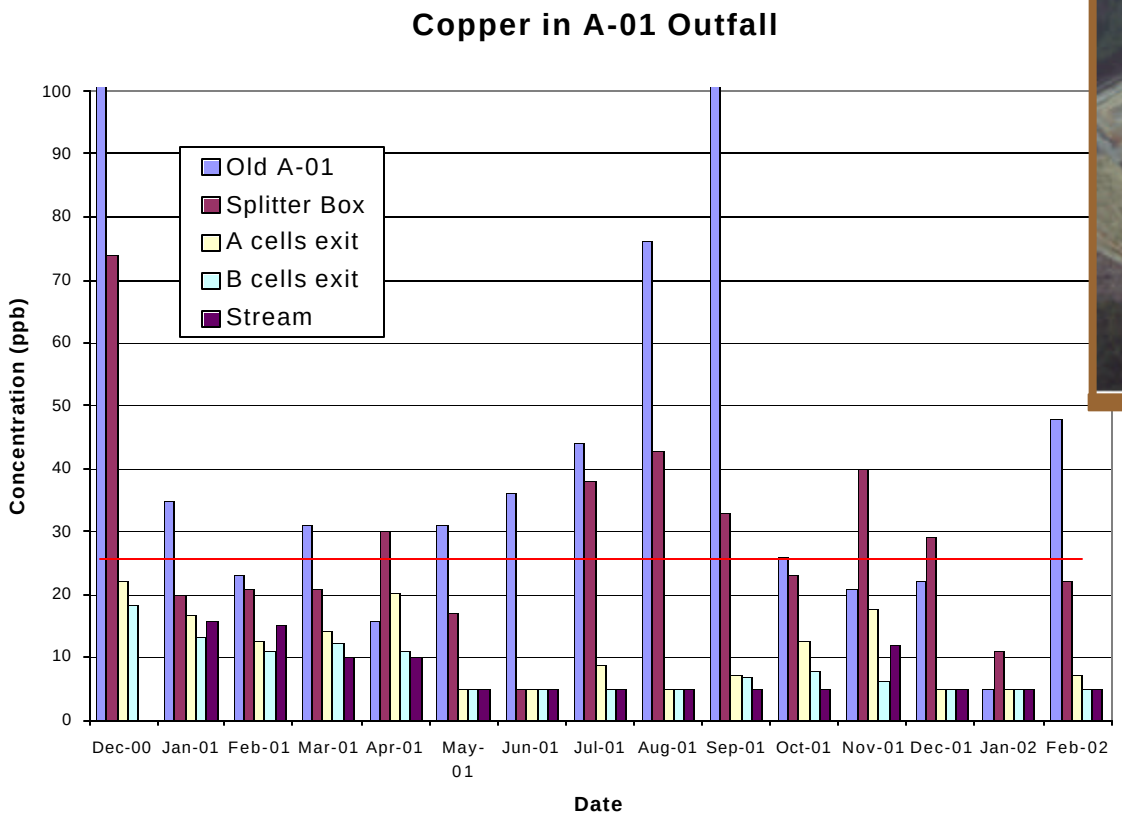
Performance Improvement:
80% risk reduction

Natural Remediation
A-01 Outfall Constructed Wetlands

Issue: Compliance with new NPDES permit requirements (copper, mercury and toxicity)

Traditional Approach: Mechanical and/or chemical treatment

Innovation: **Constructed Wetlands** using Giant Bulrush plants and organic amendments



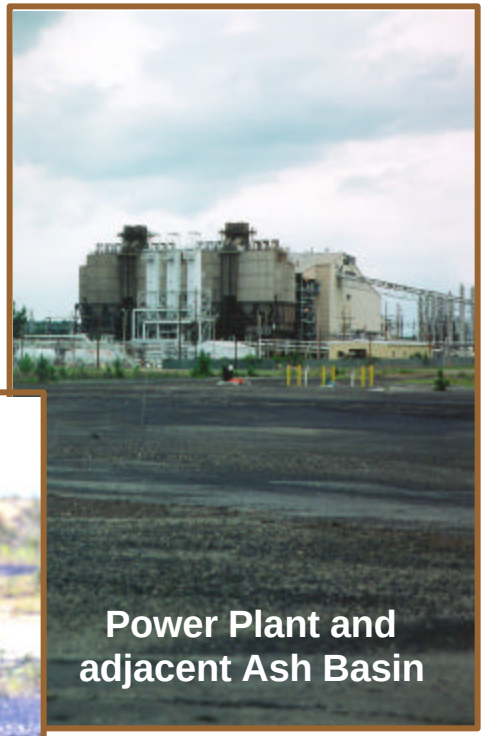
Cost Improvement:
Capital investment 5 times, annual operating costs 30 times cheaper ($20-35M, $2.9M cost avoidances, respectively)

Performance Improvement: Relatively the same as traditional approach

Natural Remediation
Vegetative Cover

Issue: Reduce risk of contamination of groundwater from ash basins with or without coal rejects

Solution: Avoid muck-n-truck by utilizing innovative approaches to storm water management such as soil and vegetative covers



Power Plant and adjacent Ash Basin

Young pine trees planted Spring 2001

Innovation at SRS

- Who We Are
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Breaking Paradigms

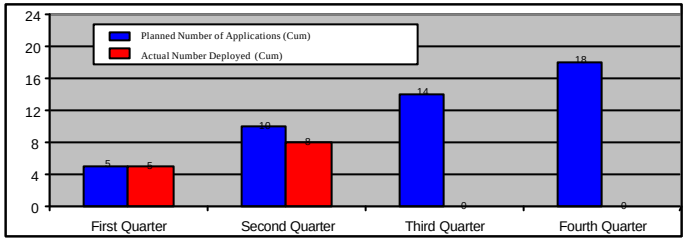
- Looking at problems differently to expand the solutions set
- Embracing the concept that many conventional approaches don’t work as well and are too expensive.
- Recognizing the need for innovation in order to have a rationally fundable program.

Building Strong Relationships

- **Memorandum of Understanding (DOE, EPA, DHEC)**
- **Strong support of public, especially the Citizens Advisory Board**
- **Collaboration among DOE, Site Operating Contractor, Site Laboratories, Universities**
  (USC, UGA, Clemson, Clark Atlanta, South Carolina State, Florida International, Claflin, Cornell, Savannah State, and others)

Managing Technology

- Documented technology plan
- ER Technology Panel
  - identifies needs
  - seeks out new technologies
  - reviews technologies for applicability, technical soundness and cost benefit



New Technologies	FY Date Planned	FY Date Deployed	Site	PBS# SR-ER
☑ Microenfractionation	1Q02	1Q02	CMP Pits	04
☐ Burge Real TimeTCE Sensor	1Q02		TNX	01
☐ Continuous Permeability Measurement with CPT (1)			D-Area	01
☐ Sulfate Reduction of Metals in Contaminated Groundwater (2)	3Q02		D-Area	01
☐ Pneulog Depth Discrete Contaminant Flux Measurement (2)			C BRP	02
☐ Purge Water Management System (tankless)	1-4Q01		Site Wide	03
☑ Solvent Tank Grouting	1Q02	1Q02	ORWBG	02
☐ QED low flow pump	2Q02		TBD	03
☑ ISOCS		1Q02	ORWBG	02
Technology Redeployments				
☐ Monitored Natural Remediation	4Q02		P BRP	04
☐ "Hot Spot" Base Injection at F Seepage Basin	3Q02		F Seepage Basin	02
☑ Borehole Flowmeter	3Q02	1Q02	H Seepage Basin	02
☑ StrataSampler	2Q02	2Q02	L-Area Southern Groundwater	04
☑ Ribbon NAPL Sampler		1Q02	A/M Area Groundwater	06
☐ "Easy Flow" Sampler	2Q02		TBD	03
☑ ISOCS		2Q02	D Area Unidentified Trash Pile	01
☑ StrataSampler	2Q02	2Q02	C Reactor Groundwater	02
☐ StrataSampler	3Q02		R Reactor Seepage Basin	04
"Baseline" Redeployments (These technologies are not included in the total number of deployments)				
☑ Soil Vapor Extraction	2Q02	2Q02	TNX	01
☑ Wireline CPT Soil Sampler	4Q02		CMP Pits	04
☑ Baroball PSVE (3)	2Q02	2Q02	A Area Isolated Hazardous Material	06
☑ Isoflow Sampler	1Q02	1Q02	A Area BRP	06
☑ Isoflow Sampler	1Q02	1Q02	Central Shops BRP	02
☑ Resonant Drilling	1Q02	1Q02	Central Shops BRP	02
☑ Resonant Drilling	1Q02	1Q02	MWMF Groundwater	02
Six Sigma				
☑ V &V of RCRA Groundwater data			Site Wide	03
☐ Solvent Tank Closure			ORWBG	02
☐ Sample Mobilization			Site Wide	03
☐ Habitability Surveys			Site Wide	03
☑ Radcon Support			Site Wide	03
☐ Field Characterization			Reactor Areas	04

(1) SRTC Independent R&D funding

(2) Technology Initiative Funding

(3) Prior testing of baroballs indicated they would not work at shallow deeps. Therefore, proposed changes are to implement PSVE.

Business Model

Baseline Technologies

- Excerpt

Problem Type	*Baseline Technology*	*Estimated Baseline Quantities*	*Baseline Unit Cost*
Landfills	Kaolin Clay Cap	217 Acres	$600K / Acre
VOC Contaminated GW	Pump & Treat	6B Gallons of GW	$5.05 / 1000 Gallons
DNAPLs	Pump & Treat	3.5M lbs of Solvents (225B Gallons GW)	$5.05 / 1000 Gallons
Analysis	Offsite Analysis	1440 Samples / Year	$2,550 / Full Suite Analysis (24-Hr. turn-around)

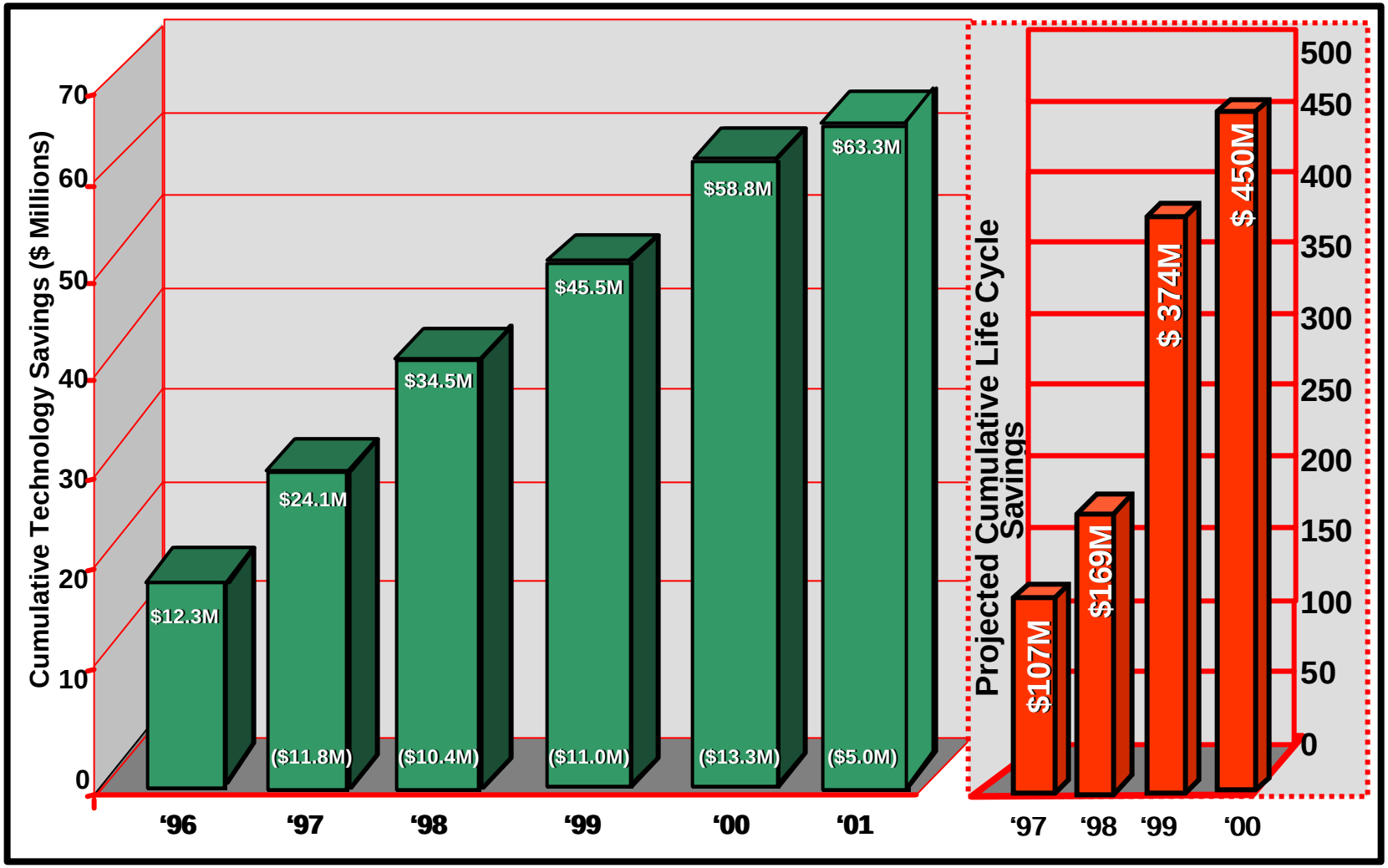
Business Model

Baseline Technologies

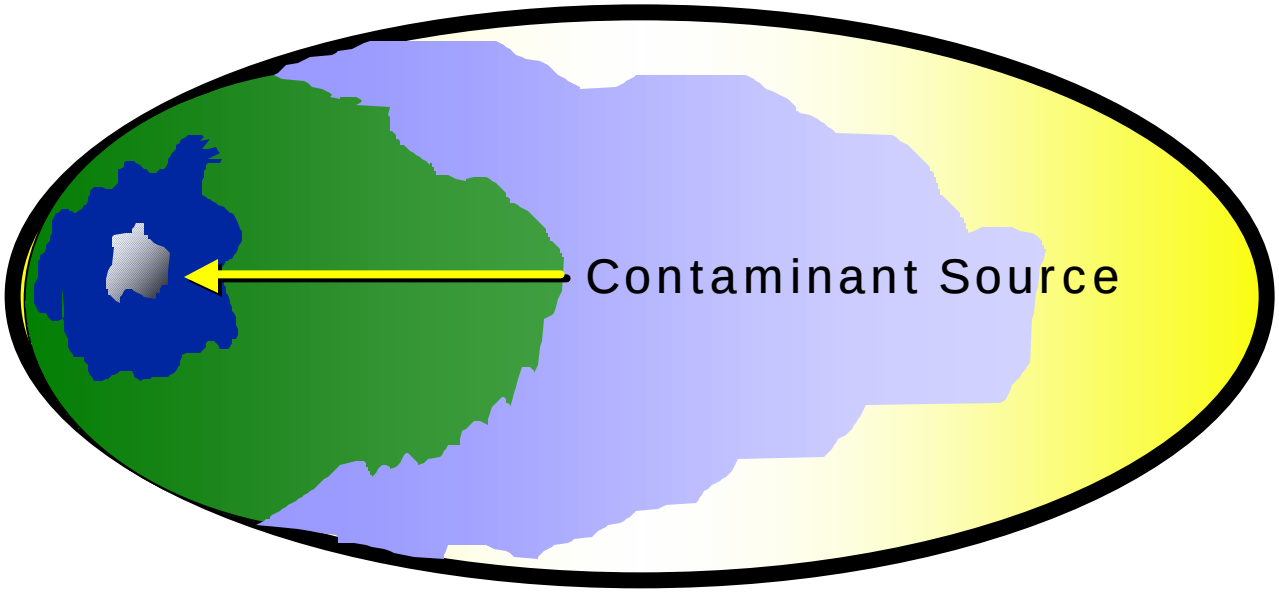
Example Cost Savings Plans

Problem Type	*Technology Deployed*	*Total Estimated LCCE Cost Savings (K)*
Landfills	Geotextile Cover	$17,050
VOC Contaminated GW	Recirculation Well	$24,620
	GeoSiphon	$19,200
DNAPLs	Dynamic Underground Stripping (DUS)	$20,963
Data Analysis	Onsite mobile lab	$44,851

Cost Savings Through Technology



Groundwater Clean-Up Strategy



Source Control

Specific Technologies:

Grouting , Capping, Pump & Treat , Soil Vapor Extraction, Steam Heating (Dynamic Underground Stripping), Phytoremediation

Primary Groundwater Plume

Specific Technologies:

In Situ Chemical Oxidation (Fenton's Chemistry), Horizontal Wells, Bioremediation, Recirculation Wells, GeoSiphon, Phytoremediation

Dilute Plume / Fringe

Specific technologies:

BaroBall™, Phytoremediation, Monitored Natural Attenuation/Mixing Zones

For additional information, contact:

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